

## By Way of a Salute

"I intend to begin graduate work at the Massachusetts Institute of Technology next fall but will need some financial assistance in order to be able to continue. For this reason I desire to know what opportunities I would have in securing a part-time assistantship in your department at this time." With these words a young man on January 27, 1922 opened his letter to the Head of the Electrical Engineering Department. Approaching his twenty-fourth birthday, he expected to receive his B.S. in Electrical Engineering from the University of Wisconsin the same year. "Kindly advise me," he continued, "as to what type of work would be required, the time, and the salary that I could expect." He was offered a position as a full time teaching assistant beginning September 20, 1922.

Thus began the affiliation of Ernst A. Guillemin with the Massachusetts Institute of Technology culminating a professional and educational career which has had profound effects on the very pillars of Electrical Engineering: in that Institute itself, in the nation, and indeed in the entire international technical and scientific community. A brilliant educator and an inspiring teacher, he became above all an enthusiastic intellectual leader with a simplicity, clarity, and elegance of thought that so many now have inherited from him.

He did very well at Massachusetts Institute of Technology from the first day he arrived. For not only did he receive his M. S. but also the same

year, when Professor Arnold Sommerfeld wrote in the spring of 1924 to suggest an exchange of graduate assistants, members of the Electrical Engineering Department faculty secured for Guillemin a Saltonstall Traveling Fellowship. This enabled the young electrical engineer from the Massachusetts Institute of Technology to study for his Ph.D. with the distinguished physicist at the Institut für Theoretische Physik, the University of Munich, Germany.

He returned to the Massachusetts Institute of Technology in 1926 where he worked energetically and with dedication year after year, leaving the Institute only once to become a visiting professor at the University of Washington in 1957. "Tech" and its students became his own workshop out of which streamed products of the highest originality and diversity. They were happy, creative years.

Ernst Adolph Guillemin was born in Milwaukee, Wisconsin on May 8, 1898. He received his B.S. in 1922 from the University of Wisconsin and the M.S. in 1924 from the Massachusetts Institute of Technology, both in Electrical Engineering. A Doctorate in Physics was awarded to him from the University of Munich in 1926.

From 1926 to 1928 he worked as an instructor in Electrical Engineering with Professor Vannevar Bush, teaching graduate courses on power transmission, while at the same time he carried out research resulting in three publications. It is remarkable but typical of Guillemin's work that his 1927 paper, "Making Normal Co-ordinates Coincide with the Meshes of an Electrical Network" is as fresh and interesting reading now, more than forty years later, as it was the day when it was written.

He was promoted to Assistant Professor in July 1928 to work with Professor Edward L. Bowles, then head of the Electrical Communication Division of the Electrical Engineering Department. Specifically his assignment was the development of a graduate course in "Advanced Network Theory, including the Design of Electromagnetic Wave Filters and Related Networks." It was a fortunate coincidence in the history of technology. For all was just right: the time, the place, the discipline and the man, giving rise to a life-long romance. A corner-stone of Electrical Engineering found a dedicated and exceptionally gifted builder. Guillemin immediately recognized the challenge and within a short period proved more than equal to it. In 1931 the first volume of *Communication Networks* appeared, followed by the second volume in 1935. This was the first, and for more than a decade, the only modern treatment of Network Theory, still regarded as a "classic."

In 1936 he was promoted to Associate Professor. From here on his teaching and research activities were committed entirely to "circuit theory." He undertook and developed an undergraduate subject for the specific needs of students studying Communication Engineering. At the same time at M.I.T. a comprehensive Course Revision Program was



under way. Professor Guillemin took part in it in a very significant way. He made substantial contributions to *Electric Circuits*, the first of the E. E. Staff Series books in 1940, and again to the subsequent volume *Applied Electronics* which appeared in 1943.

His efforts by this time had become widely recognized. In the fall of 1940 he acted as consultant to the Microwave Committee of the National Defense Research Committee, later on known as Office of Scientific Research and Development. He spent up to one half of his time consulting with various groups in the Radiation Laboratory of the Massachusetts Institute of Technology on a large variety of problems dealing with the design of electrical networks for special applications. Outstanding among those was the development of a network for the generation of radar pulses—the “Guillemin Line.” In 1941 he took over the administrative responsibility for the Communications Option of the Department of Electrical Engineering, a post vacated by Professor Bowles then an expert consultant to the Secretary of War.

He was promoted to full Professor in 1944, his efforts continuing to be on the Course Revision Program. This work resulted in the superb, scholarly book, *The Mathematics of Circuit Analysis*, released in 1949, enabling many engineers to acquire with confidence, an understanding and a working knowledge of a number of sophisticated mathematical concepts and techniques.

Since he joined the faculty of M.I.T. he supervised several theses each year. At first the topics spanned a wide area of Electrical Engineering with “Circuits” the predominant flavor in all of them. From 1945 on, however, the titles of the theses completed under his supervision clearly reflect the emergence of the new field to which he gave form. Into them went years of feverish activity, reshaping the traditional character of electrical engineering education with sweeping revisions in approach and method. In the classroom his attention was focused alternately from the undergraduates, to the graduates and back to the undergraduates. His revolutionary textbook for sophomores, *Introductory Circuit Theory*, appeared in 1953. More than a book, this was a unique, bold experiment in undergraduate education which, by storm, took educators and researchers alike. Some of the most abstract mathematical notions were there, with lucid, clear presentations stressing the physical interpretations afforded by circuit theory. New and exciting horizons were opened up for both the students and the teachers. How many textbooks have appeared and continue to be written in all parts of the world, adopting “Guillemin’s approach” in one form or another? No one knows.

All along, Network Theory was expanding both in depth and in coverage, in no small part as a result of the efforts of Ernst A. Guillemin and his students. In particular the emphasis shifted from analysis and design to synthesis and optimization. The new developments were

continuously incorporated in Guillemin's own graduate courses, achieving wide dissemination from notes and word of mouth leaking out from M.I.T. Finally in 1957 the long anticipated "Synthesis of Passive Networks" appeared as a coherent, polished body of knowledge, already familiar to and practiced by Guillemin's disciples. As with his previous treatise, a surge of similar publications followed, but this one book marks the creation of what we now call Network Synthesis. Since then the fundamental notions of Network Theory have penetrated and influenced a much broader range of problems, particularly in control and communication systems. A remarkably large number of these developments have their roots in the teaching and writing of Ernst A. Guillemin. His disciples have carried with them a philosophy and a viewpoint which they learned from him and which continues to give them confidence in their ability to cope with many new problems arising in modern technological systems.

In 1963 he became "Professor Emeritus" and the same year his latest book *Theory of Linear Physical Systems* was released. Highly original, it is sparkling with clarity, and an enthusiasm for the message of the universality of the approach he more than any one man helped to create. Once again he proved to be a pioneer in thought and in spirit.

Throughout all the years at "Tech" he maintained close research ties via his own efforts and through the thesis work he supervised. To all who came to him he gave generously with a sensitive, gentle way. Surely the effectiveness of a teacher is measured by the quality of the students he attracts, the accomplishments they make in later years and the numbers he influences. In each of these counts Professor Guillemin holds a unique record unequalled by any other educator of this century. Students from all parts of the nation and the world came to study under his direction. More than a hundred were fortunate and all of them value it as a distinction—to have their theses completed under his guidance: among them, some of the outstanding leaders of the next generation. There is no major university in the United States today that does not have among its faculty at least one of "Guillemin's students." It is impossible to exaggerate the importance of his influence on Electrical Engineering and even on technology in general.

In March 1948 he was awarded the President's Certificate of Merit for his outstanding wartime contributions.

In 1960 Massachusetts Institute of Technology honored him with the appointment as the first permanent holder of the Edwin Sibley Webster Professorship.

The Institute of Radio Engineers awarded him its 1961 Medal of Honor "for outstanding scientific and engineering achievements."

The American Institute of Electrical Engineers bestowed on him in 1962 its Medal in Electrical Engineering Education.

He died on April 6, 1970.



Professor Guillemin was known throughout the world for his personal research in the field of network theory and for his ability, as exemplified in his writings, to interrelate his own contributions with some of the obscure and obtruse researches of others, molding them into a coherent body of knowledge. Almost everyone who is interested in modern network theory is indebted to Professor Guillemin directly or indirectly for many of his ideas. But above all, he was known as a sparkling and inspired teacher with a rare talent for communicating, not only the specifics of his subject, but also those arts and attitudes necessary for effective research in any field. Indeed, teaching in the classical sense had been the preeminent purpose of his entire professional life. His students (and unanimously they agree *they are* his students) are his most important products; they are the motivation and the measurement of his achievements. They are found in the United States and abroad, in eminent positions as teachers, researchers and practicing engineers.

Professor Guillemin's confident, penetrating approach to problems has served as an example to his students in every endeavor and in particular to those who pioneered new fields such as control, computer and information theory. It would be impossible to overestimate the contribution to technical progress and National Defense made by his students and attributable in significant measure to their contact with Professor Guillemin.

Professor Guillemin was a figure of outstanding strength, the embodiment of the inspired ideal teacher and scientist of integrity—a man with unswerving devotion to his profession, a person of extraordinary humility, and at the same time a warm-hearted, a very human man. His greatness stands out because of the scholarliness of his work, the esteem in which he was held, the breadth of his influence and the extent to which the productivity of his students have in turn multiplied his own contributions many times. The impact he has had on the whole field of Electrical Engineering will long endure.

Professor Guillemin's individual contributions to network theory have been so woven by him into the general fabric of his expository material that they are likely to be overlooked. The way he has welded together topological, algebraic and function-theoretic concepts into a most powerful tool for attacking problems in network analysis and synthesis is not only a beautiful and elegant discipline, but has also been of great practical use. His ideas and techniques have been so fruitful that they transcended the bounds of his specialty and have influenced the basic thinking of neighboring fields. M.I.T.'s major contribution in the evolution of engineering and science has been educational in nature and M.I.T.'s major products are its graduates; the single man in the center of the educational process of the Electrical Engineering Department was Professor Guillemin. Inventions, new theories and texts are primarily

consequences of the technological needs of the moment and the current state of the field; greatness in teaching is, on the other hand, a unique contribution, achievable only by the individual and largely independent of time and the changing state of the technology.

The creativity of Professor Guillemin's approach to the presentation of new ideas was singularly outstanding. As a teacher he was a trail blazer at the frontier. To improve established fields is relatively easy. Professor Guillemin's work *laid out* new fields in a way which did not need any substantial improvement subsequently. Professor Guillemin did not dominate the research he supervised; instead he inspired the progress of the researcher without intruding on his freedom. The key to the value of his guidance was that he was able to induce an attitude toward research areas quite different from their thesis work. One seldom finds in the academic world a man who stood so high in his professional research accomplishments and who at the same time was so completely tireless in sharing his knowledge with others, and giving of his time and enthusiasm to his students.

Modern circuit theory is a difficult complex technical discipline and yet it is understood, used and enjoyed by a very large number of communications, electronics and control engineers. That it is understood by so many is due in no small measure to Professor Guillemin's activities. He was a pioneer, who established a sound, scientific approach adopted by numerous others. It can truly be said of Professor Guillemin that he, more than any other man, gave contemporary Electrical Engineering the form and structure it now possesses.

It is impossible to exaggerate the influence that Ernst A. Guillemin has had in the technological thought of our times. When he died, three generations of applied physicists, applied mathematicians and electrical engineers, among them numerous leaders in education research and industry, payed tribute to his memory, recalling with gratitude the intellectual viewpoint, attitude and inspiration they received from him.

# Publications of E. A. Guillemin

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2. **Electric Circuits** (*Collaborator*) John Wiley & Sons, Inc. 1940
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7. **Theory of Linear Physical Systems** John Wiley & Sons, Inc. 1963

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### III. PATENTS

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